State Water Resources Control Board

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GRADE IV OPERATOR CERTIFICATION EXAMINATION INFORMATION AND SAMPLE QUESTIONS

The Grade IV examination contains questions regarding the following subjects: safety practices, hazards encountered during operations, sampling and analysis of wastewater constituents, operation and maintenance procedures in preliminary, primary and secondary treatment unit processes, anaerobic sludge digestion and disinfection. It also includes operation and maintenance of wastewater stabilization ponds and state regulations regarding the classification of wastewater treatment plants and operator certification. Questions may deal with sludge handling and evaluation of wastewater unit processes as well as overall plant performance. In addition, the Grade IV examination includes questions on process control, activated sludge process modifications and tertiary treatment, requirements and practices for water reclamation and reuse, supervision/management responsibilities such as energy management, safety program development, operator training and budget development and control. Examinees will be asked to write essay answers to some questions.

The Grade IV examination also contains mathematical questions. Examinees may be asked to write essay answers and calculate problems including heat value/gas generation from an anaerobic digester, BOD/nitrogenous BOD calculations, effects of process adjustments/changes, polymer usage/dose, efficiency and loading of solids thickening processes, disinfection options/dose/residual/cost, use/calculation of process control variables, hydraulic or organic loading rates, pumping efficiency/cost, nitrification and effects on plant operations and infiltration and inflow. The examinee should be familiar with typical calculations related to the subject matter listed in paragraph 1. Examinees must work out the math problems. Answers to math questions that are not supported by calculations will **NOT** receive credit.

Examinees are given 4 hours to complete the examination. The question format is as follows:

25 Multiple Choice Questions	@	2 point each
5 Math Problems	@	8 points each
1 Mandatory Essay Question	@	15 points each
4 Essay Questions (Work 4 of 6)	@	10 points each
TOTAL POINTS		145

The following are examples of the types of questions that you would find on the Grade IV certification examination (see attached key for answers).

Multiple Choice Questions

1. Which one of the following statements is TRUE regarding disinfection?

    a. The Iodometric Back Titration Method using the amperometric titrator for measuring chlorine residuals is an acceptable method if this data is to be reported on NPDES reports.
    b. Because of the low ammonia concentration in a highly nitrified secondary effluent, disinfection of this effluent will always be more effective.
    c. HTH is a more effective disinfectant than chlorine.
    d. 10 mg/L or more of organic nitrogen is desirable when disinfecting a completely nitrified secondary effluent.
    e. Nitrate creates an excessive demand for chlorine.

2. Denitrification in an activated sludge plant involves:

    a. The oxidation of ammonia to nitrates.
    b. High concentrations of DO in the mixed liquor as it settles in the secondary clarifier.
    c. The biological oxidation of nitrates to nitric oxide.
    d. The biological reduction of nitrates to nitrogen gas.
    e. Poor compaction of the mixed liquor as it settles in the secondary clarifier.

3. An ORP (oxidation-reduction potential) probe:

    a. Is often used to measure pH of a secondary effluent.
    b. Is often used to control hydrogen sulfide corrosion in a concrete sewer.
    c. Measures, in millivolts, the difference in electrical potential between oxidants like chlorine and reductants such as organic matter.
    d. Must be cleaned daily when used to monitor chlorine disinfection.
    e. Sends a 4-20 mA signal directly to a chlorine controller.

4. The float blanket in a DAF unit appears well flocculated and concentrated. Too low a flight speed would likely result in:

    a. Using excessive amounts of air.
    b. Float solids that are too thick.
    c. Too low an air to solids ratio.
    d. Poor thickener underflow quality.
    e. Deflocculation of the float solids.

5. Which one of the following statements is TRUE regarding trickling filters?

   a. When calculating the organic loading rate to a trickling filter, one should include the BOD of the recirculated flow in this calculation.
   b. Recirculation ratio is defined as the ratio of Q to Q_r both having the same units.
   c. Letting a trickling filter dry out is a common strategy for controlling psychoda.
   d. Reducing recirculation to a trickling filter is an appropriate strategy to promote the nitrification of ammonia.
   e. The TF process may be improved significantly by the addition of an aerated solids contact which improves the settling of the sloughing.

6. A strategy for controlling filamentous bulking, used with increasing frequency in recent years, has been:

   a. The use of an anoxic selector
   b. Use a DAF thickener to selectively float the undesirable filaments so that they may be removed from the mixed liquor.
   c. The application of 50% hydrogen peroxide solution to the surface of the aeration tank in order to destroy the undesirable filaments.
   d. The application of a 1% aqueous solution of “bluestone”.
   e. The application of granular HTH to the surface of the aeration tank.

7. Liquid ferric chloride may be used as a flocculant. This chemical:

   a. Is typically applied at the dose rates of 1 to 10 ppm when used to precipitate phosphorous.
   b. Should be treated as an acid for purposes of safe handling.
   c. Should be stored in galvanized drums.
   d. Adds important alkalinity when used to remove phosphorus.
   e. Raises the pH of wastewater to which it is added.

MATH PROBLEMS

8. A 6-year old pump motor is to be replaced. The new motor, just like the old one, would run 75% of the time. Both existing and replacement motors would operate at 100 OUTPUT HP. The existing motor efficiency is 86% while the replacement motor would be guaranteed at 94% efficiency. Electricity currently averages $0.0780 per KWH. Calculate the energy cost savings per year (to the nearest dollar, assume 365 days/yr) if the existing pump is replaced with the new pump (neglect any consideration of impact upon demand charges or interest on capital).

9. Using the data given below determine the number of pounds of dissolved oxygen transferred to water in an aeration tank by 1000 cubic feet of air. Assume that air is 21% oxygen EITHER BY WEIGHT OR BY VOLUME.

   Oxygen to Water Transfer Efficiency: 6.35%
   Air weighs 0.075 pounds per ft^3

10. A 2 meter belt press is being used to dewater anaerobically digested sludge (3.8% TS) at the rate of 75 gallons/min. It is operated 6.5 hours per day. The feed sludge is conditioned with a polymer solution and then fed to the press. A 25 cubic yard truck full (level road) of sludge cake (20.5% TS, bulk density 65.8 Lbs/ft^3) is hauled away at the end of each day. Calculate the percent solids recovery.

ESSAY QUESTION

11. Lab data from your 100,000 gallon primary anaerobic digester, which receives primary sludge only, is shown below. Using this data:

(a) Calculate the average volatile solids reduction. Compare your calculated value to generally accepted ranges for a healthy anaerobic digester. Comment.
(b) Compare the other data to expected ranges.
(c) Is this digester experiencing an operational problem? If so, what is the problem. Name three steps that may be taken to mitigate the problem.
(d) Should slake lime be added? Why or why not?

DATE	pH	ALK. (mg/L)	VOL. ACIDS (mg/L)	% CO_2
9/2	7.1	3200	280	35.5
9/9	7.0	3020	320	36.0
9/16	6.9	2800	400	37.7
9/17	6.85	2720	450	38.2

DATE	RAW SLUDGE % TS	RAW SLUDGE % VS	DIG. SLUDGE % VS
9/2	5.4	65.5	56.0
9/9	5.0	66.7	53.8
9/16	4.9	65.9	54.2

12. You are the superintendent of a 100,000 gpd conventional activated sludge plant which discharges into a shallow bay. Your NPDES permit currently sets a discharge limit of 5 mg/L for total ammonia-nitrogen in your effluent. However, the Regional Water Quality Control Board at the request of the Department of Fish and Game will soon revise your plant's discharge requirements and have even lower total ammonia limits so that certain species of fish may be re-introduced into the bay. The proposed limit is as follows:

Total Ammonia-Nitrogen

Maximum Concentration	Time of Year
2.0 mg/L	November through March 15th
1.0 mg/L	March 16th through October 31st

Answer the following questions:
(a) What is total ammonia-nitrogen and why are such low limits being considered?
(b) Why are there different limits during different parts of the year?
(c) Identify and briefly discuss three (3) impacts that these new limits will have on plant operations.

ANSWER KEY

GRADE IV

1. A
2. D
3. C
4. D
5. E
6. E
7. B
8. $3813/YR
9. 1 LB AIR
10. 98.2%

THINGS TO KEEP IN MIND

1. A one-page “Formulas and Equivalents” sheet is included in the front of each examination (see attachment).

2. All multiple choice questions have only one right answer.

3. On the math problems, including the multiple choice math, show all your work so that you might receive partial credit.

4. There are some sections (math on the Grade III) where you have to choose which problems to answer. Read through these sections and decide which problems you want to answer before you begin.

5. When the instructions say to work 7 out of the 8 problems, do not waste time working 8 of these problems – there is no extra credit for extra problems answered.

6. On the math and essay problems, if you only know part of an answer, by all means put it down! SHOW YOUR WORK.

7. REMEMBER: In order to pass, you must achieve an overall score of at least 70%. Also be aware that you are required, in addition, to score at least 50% on the math section of the examination to pass.

STATE WATER RESOURCES CONTROL BOARD
OPERATOR CERTIFICATION EXAMINATION

EQUIVALENTS

1 acre = 43,560 square feet

1 cubic foot of water = 7.48 gallons

1 gallon = 8.34 pounds

1 day = 1,440 minutes = 86,400 seconds

1 million gallons/day = 694 gallons/minute = 1.547 cubic feet/second = 3.069 acre-feet/day

1% = 10,000 mg/L

$\pi = 3.14$

1 in. mercury = 1.133 feet of water

1 psi = 2.31 feet of water

1 HP = 0.746 Kw = 550 ft-lb/sec = 33,000 ft-lb/min

FORMULAS

Area of a rectangle = Length x Width

Area of a circle = $\frac{\pi}{4}$ x Diameter^2 = 0.785 x Diameter^2

Volume of rectangular tank or circular tank with uniform depth = Area x Depth

Volume of cone = 1/3 x Base Area x Depth

Circumference = π x Diameter

Velocity = $\frac{\text{Flow}}{\text{Area}}$

Deterntion time = $\frac{\text{Volume}}{\text{Flow}}$

Pounds/day = 8.34 x Flow, mgd x Concentration, mg/L

F/M = $\frac{\text{Pounds of BOD applied per day}}{\text{Pounds of MLVSS under aeration}}$

MCRT = $\frac{\text{Pounds of MLSS in secondary system (aeration tank + clarifier)}}{\text{Pounds of MLSS leaving secondary system per day (effluent + WAS)}}$

Water HP = $\frac{\text{Flow, gpm x Total Head, ft}}{3960 \frac{\text{gpm} \cdot \text{ft}}{\text{HP}}}$

Brake HP = Power to electric motor x Motor efficiency